Chapter 33

Critical Skills, Mathematics, and Disinformation: a Necessary Dialogue for the Formation of the 21st-Century Citizen

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José Ricardo Ledur
ULBRA/RS
Orcid.org/0000-0003-4671-2487
ri125@hotmail.com

Renato Pires dos Santos
Orcid.org/0000-0003-1427-9973
RenatoPSantos@ulbra.edu.br

ABSTRACT
Education, in particular, has the task of equipping young people to become contributing members of a democratic society. Specifically, mathematics and science education has been the central place where students learn the skills to discern facts, process information and draw conclusions, and practice ways of seeking true knowledge. This art of thinking is considered vital for democratic societies to thrive. In the contemporary world, the information society requires from its citizen's skills that provide the ability to access, interpret and evaluate the information that is made available at an increasingly fast pace. Literacies, especially in the fields of science, mathematics, and media, are increasingly becoming essential elements for the country's autonomy, quality of life, and development. This work aims to highlight converging points between mathematical literacy in the context of post-truth and the growing proliferation of misinformation, seeking to provide greater clarity about these concepts as well as emphasizing the importance of this skill for a full education of our students. Analyzes of information conveyed through the media are presented, emphasizing the need for the capacity for analysis and mathematical interpretation for the critical evaluation of news. We consider that, in general, in Brazilian education, in practice, these concepts are still treated in an incipient way. And since the relationship between literacy and knowledge is complex, as both are concepts in transformation, their discussion seems to be increasingly necessary.

Keywords: Mathematical literacy. Post-truth. Misinformation.

1 INTRODUCTION

The construction of a civic education requires the subject's autonomy to develop their points of view about reality with criticality. This means not living passively, naively accepting everything that is presented, having a voice, and making yourself heard in this discursive plot (GOMES et al, 2020). In this sense, citizens must be given the necessary skills for an adequate understanding of the world and active participation in decision-making processes. These competencies are related to the concepts of literacy, literacy, and literacy which, although they admit a range of definitions, are essential for achieving full citizenship.

Notably, in the society of the beginning of this 21st century, characterized by the ease of access and consumption of information, skills are needed to search and evaluate information, considering that internet access and adherence to social media have been significantly expanded. In the final report of the UK Commission on Fake News and the Teaching of Critical Literacy in Schools (NATIONAL LITERACY

TRUST, 2018), researchers emphasize that the new digital media landscape can be confusing and overwhelming, even for media consumers. experienced adults. It is even more so for children and young people, because:

> Many have grown up with the online world available as a constant and convenient source of information, but they may not necessarily possess the necessary knowledge and skills to assess the reliability of what they find there (NATIONAL LITERACY TRUST, 2018, p. 6).

The ability to use the information accessed is important, and it becomes worrying, especially when we consider the literacy level of the population and the relationship of individuals with news and information, both false and biased.

The skills needed to access and evaluate information, more than at any other time in human history, have been perceived as fundamental in the face of the torrent of information that can be accessed today. The vulnerability of users generated by misinformation in the context of post-truth, informational hyperinflation (TAPIAS, 2006), and deficiency in the ability to read and assess the accuracy, reliability, and partiality of online information (COIRO et al., 2015) shows that " having the skills, strategies, and dispositions to understand and think critically about the information on the Internet will play a central role in students' success in the information age" (COIRO et al., 2015, p. 10).

In this context, we agree with Arnold (2019, p. 95) when he states that "we have to abandon the fixation on the content of curricula to strengthen the next generation as individuals, ensuring that they are capable of mastering new situations in a self-directed and appropriate way". According to this author, the main education theorists have already recognized that these concerns are in line with the concepts of formal educational theory, which seek a deeper explanation of how to cultivate and promote such skills.

2 THEORETICAL REFERENCE

Students are no longer just getting information within the classroom or from trusted media services, but are turning to social media sites to learn information about the world. Larkin (2017) points to studies by reputable groups, such as the one conducted by the Stanford History Education Group, which carried out the largest study to date on the ability of adolescents to question information online (WINEBURG: Mc GREW, 2017). The study indicated the students' lack of ability to decipher the information they find.

An alternative that seems to be feasible in the fight against disinformation is the provision of more information based on verifiable and quality facts. However, this is not an equation with a simple solution, as the qualities of distorted and/or biased narratives are increasingly elaborately constructed and mimicking reliable news. To get around this obstacle, it is necessary to develop skills and competencies that favor a meaningful and critical reading and analysis of the world that is presented to us.

Navigating the news, in a digital media scenario full of information and frequent updates, requires that web users, the consumption of information, have developed critical literacy skills. These skills make it

possible to put information in context, differentiate fact from fiction, assess bias and distortion, and recognize deliberate misinformation when we encounter it (NATIONAL LITERACY TRUST, 2018).

While disinformation campaigns show only one side of the facts as the absolute truth, the critical citizen will seek additional information to identify other biases in the speeches. If misinformation fills and confuses, literacy skills lead people to seek the complexity of facts (BRISOLA; DOYLE, 2019, p. 284).

Pivaro et al (2019, p. 107) emphasizes that "having access to a sea of information in the palms of the hands, it is believed to be extremely important to study how citizens interact with this information". In addition, several scholars have warned of the need to provide opportunities for the development of skills for different literacies that develop in the student the skills and competencies to analyze, evaluate, interpret, and critically deliberate on sources and information, especially those obtained online (BARZILAI; CHINN , 2020; PÉREZ-ESCODA et al, 2016).

According to Tenreiro Vieira (2009), currently, in several countries, it is argued that the teaching of science and mathematics in basic and secondary education should be focused on principles that promote critical thinking, scientific literacy, and mathematical literacy of all the students. Such principles underlie the skills of different literacies. Regardless of the type of literacy, the development of these skills is fundamental for the formation of a critical citizen, as it implies not only reading and understanding texts and data, but also conscious and critical social interaction (GIORDANO et al., 2021).

For the OECD (2019), understanding mathematics is fundamental to preparing a young person for life in modern society. Countless everyday problems and situations require some level of understanding, reasoning, and mathematical tools so that they can be fully understood and treated. Therefore, "it is important to understand the extent to which young people leaving school are adequately prepared to apply mathematics to understand important issues and solve significant problems" (OECD, 2019, p. 75).

According to Ojose (2011), literacy in mathematics does not imply detailed knowledge of abstract contents and complex sophisticated mathematical formulas, but rather a “wide understanding and appreciation of what mathematics is capable of achieving” (OJOSE, 2011, p. 89).

According to Ritzki and Priatna (2018), the problems encountered in daily life are increasingly difficult and complicated, generating demands on problem-solving skills that not only require content knowledge but also critical thinking skills, problem-solving, creativity, innovation, communication, collaboration, flexibility, adaptability, initiative, among others, as well as informational and mathematical literacies, which are two of the necessary components to build 21st century skills.

Levitin (2017) argues that more information has been created in the last five years than in all human history before that period and that, alongside true information, there is a large number of others that are not. For the author, disinformation has been a fixed element of human life, but the big problem we face today is that disinformation has proliferated and lies can be turned into weapons to produce social and political ends against which we would like to be protected.

At present, as at no other time in our history, however, the threat of disinformation is at its highest point and this also applies in the field of education" (KENDEOU et al, 2019). In this regard, education plays an important role, because if we consider that one of its priorities is to ensure that students are lifelong learners, "we need to make sure that we are giving students the appropriate lessons and strategies in navigating a world which operates its information mainly through the Internet (LARKIN, 2017, p. 17).

According to Manalu et al (2019), the ability of the younger generation to obtain large amounts of information in the current internet age is not always accompanied by their ability to assess the quality of information. In this way, developing different literacies is an urgent demand, to "form citizens who are more autonomous and committed to facts, and less susceptible to emotions and beliefs, as seen in this moment of post-truth" (GOMES et al, 2020, p. 12).

Several studies point to the importance of activities in the classroom that contribute to the development of information literacy (WIJAYA, 2016). According to the OECD (2019), problem-solving can develop information literacy because it mainly involves defining, searching, evaluating, selecting, organizing, analyzing, and interpreting information.

In this context, mathematical literacy offers an important contribution to the critical understanding of information, as a person who has developed these skills can estimate, interpret data, solve day-to-day problems, reason in numerical, graphic, and geometric situations, and communicate using mathematics (OJOSE, 2011). Therefore, literacies are some of the keys "to deal with a changing society. Literacy in mathematics is as important as proficiency in reading and writing" (OJOSE, 2011, p. 91).

3 RESEARCH METHODOLOGY

This work is qualitative, as it is documental and bibliographical. News analyzes were carried out with statistical data to demonstrate mistakes, intentional or not, that can influence and shape opinions based on distorted or manipulated information. With this, it is intended to demonstrate the importance of developing mathematical and statistical literacy skills that favor the critical understanding of the information conveyed both in traditional media and in digital media and social networks.

In this work, we present the analysis of news and situations in which the informative power of statistics can be distorted to manipulate information and confuse opinions.

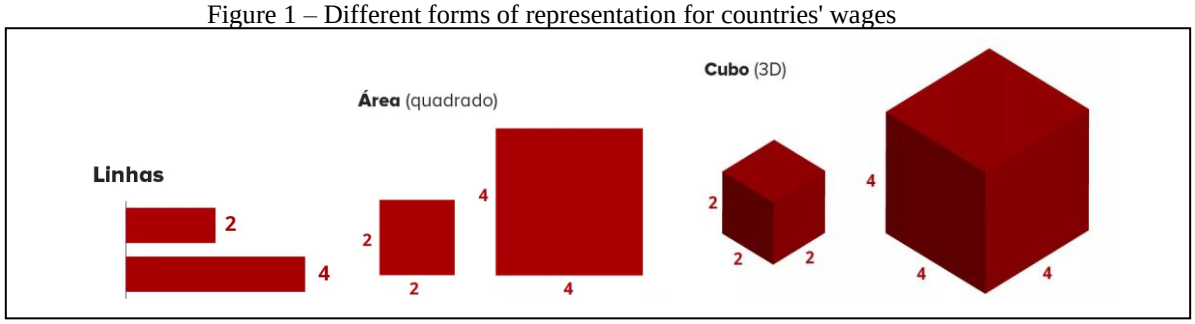
4 DATA DESCRIPTION AND ANALYSIS

Numerical data are usually presented in news and advertisements. One of the most common ways is that they are provided in the form of graphics as these are very useful ways of communicating information. And also easily manipulated in different ways when the intention is not just to inform. Although many graphs present real data, their presentation can lead the reader to erroneous or distorted interpretations, an effect that can be as harmful as that provided by false news.

Such manipulations can be done either by the type of graph chosen or by distorting or omitting axes, using figures that compromise the real proportion between the data, or even incorrect inferences from the data presented. According to Stoffers and Hackett (2017), graphs can be powerful tools for sharing data with the public, but just choosing the wrong type, incorrectly labeling the axes, or using an inconsistent or inappropriate scale for the information leads to an incorrect interpretation of that data.

Huff (1968) exemplifies a very simple case, where a comparison is made between the wages of workers in two countries – one small and the other great power. In the small country, the average salary was 2 monetary units and in the other, it was 4 units. Dana (2017) draws attention to different forms of graphical representation that can visually distort the comparison, as shown in Figure 1.

Figure 1 – Different forms of representation for countries' wages

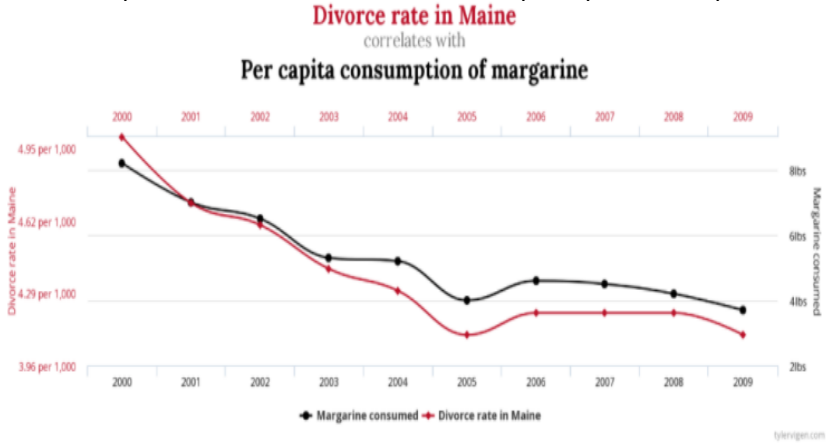


Source: Dana (2017)

For the same piece of information, different representations can lead to different comparative perceptions. In the two-dimensional representation, the areas of the figures and the volumes in the three-dimensional representation suggest a greater than the real disparity between wage differences.

Relating examples of numerical misinformation, Levitin (2017), presents situations that demonstrate how poorly prepared statistical data and graphics - with the aim of confusing or to forge biased opinions, or not – can offer a distorted perspective and produce wrong conclusions and favor inappropriate decisions. In Figure 2, the author presents a supposed correlation between the divorce rate in the American state of Meine and the per capita consumption of margarine.

Figure 2 – Comparison between the divorce rate and per capita consumption of margarine.

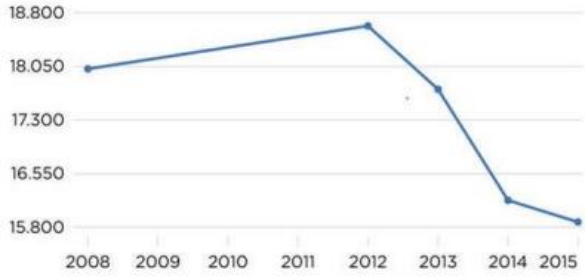


Source: https://estatisticafacil.org/2020/10/08/estatistica-fake-news/

Although graphically it may be possible to infer a correlation between the two variables – the authors found a correlation of 99% – it is not possible to state, with these data, the existence of a causal relationship between divorces and margarine consumption.

In Figure 3, Silva (2019) presents a graph that leads us to believe that the number of abortions in Portugal declined significantly over the period considered.

Figura 3 – Número de abortos em Portugal no período de 2008 a 2015.



Fonte: Silva (2019)

In this example, it is necessary to consider the cut produced on the vertical axis, which starts at 15800, which gives the impression of a drastic drop in the number of abortions and even generates a false perception that the trend is approaching zero. Furthermore, a context problem can be seen in this representation, as the period before 2008 is not considered, since the authorization of abortion in that country occurred precisely in the year in which the sampling shown in the graph begins.

Statistical data, as well as other ways of communicating information, can be used from different angles of view, according to the intentions of those who use them. In this sense, we can mention measures of central tendency that can serve different purposes. Silva (2019) cites an example involving the wages of workers in a company. Assuming the values were equal to 1300, 1300, 1300, 1300, 1700, and 2500 currency units. In the view of the class union, wages would be considered low, considering the mode, very close to the value of the current minimum wage. The employer, on the other hand, using the arithmetic mean, would consider the wages to be very good since workers receive an average of 1500 monetary units, a value above the current minimum wage.

5 CONCLUSIONS

Post-truth and the proliferation of disinformation are cultural phenomena and must be treated as such. There are strong arguments and evidence that different literacies – informational, mathematical, and statistical, among others – are efficient and necessary mechanisms for the development of critical, conscious, and judicious citizen participation in the face of the informational avalanche in which we are currently involved.

Information literacy and mathematical literacy have common features. In addition, the competence to analyze and evaluate data, claims, and arguments in a variety of representations and draw appropriate

scientific conclusions. (OECD, 2015, p. 7) generally requires mathematical knowledge and its critical interpretation.

Specifically, about information with statistical data, Levitin (2017) emphasizes that statistics are not made of facts, but of interpretations. And that, "people choose what to count, how to count, which of the resulting numbers they will share with us and which words they will use to describe and interpret these numbers" (LEVITIN, 2017, p. 19).

Santos and Vieira Júnior (2019) warn that teachers, when discussing subjects inherent to their area of knowledge, should pay special attention to scientific information, as well as those containing statistical data, disseminated in different media, mainly so that students are encouraged to think this information critically and based on the concepts that Science and Mathematics advocate.

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